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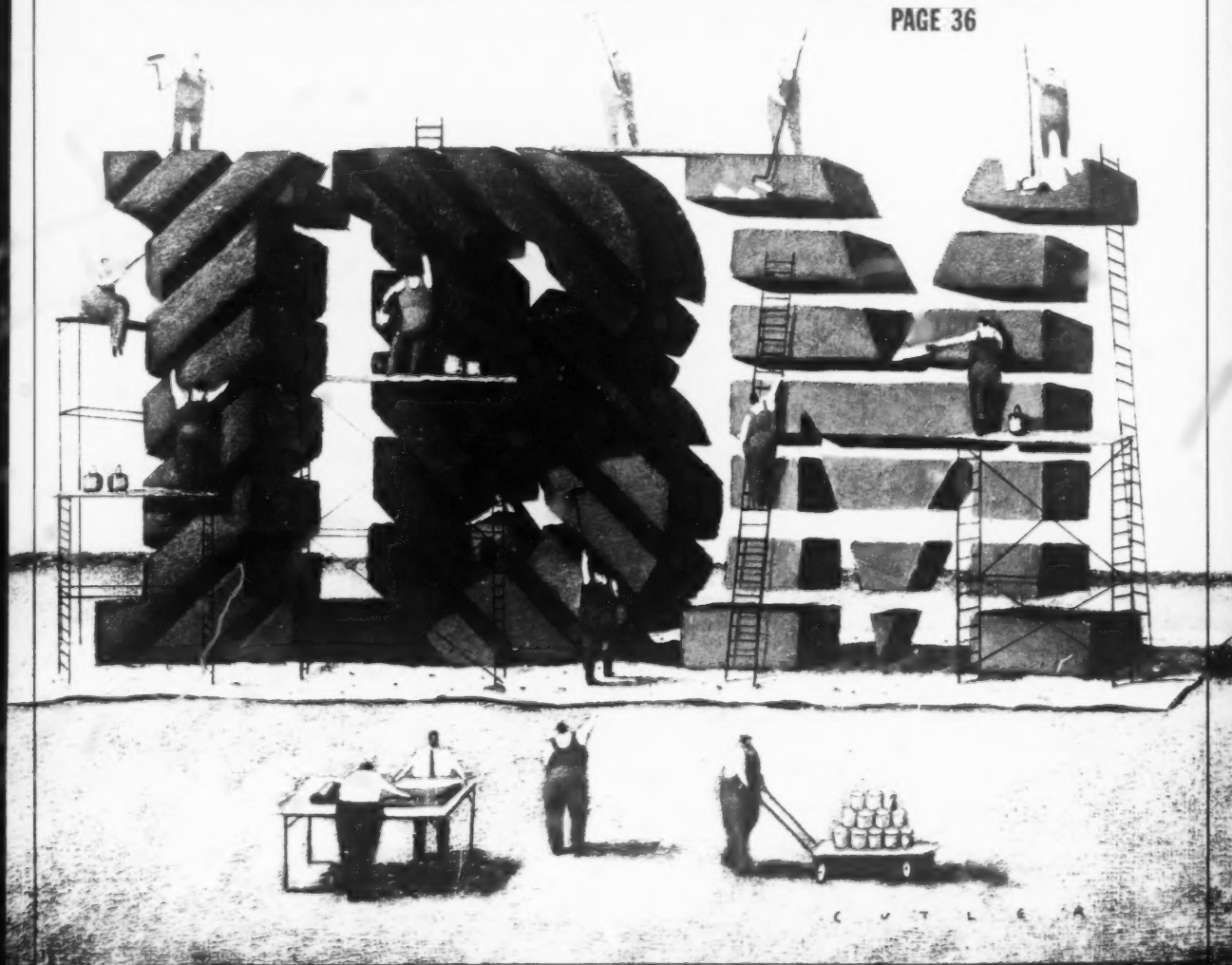
A CARNER PUBLICATION

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES—WORLDWIDE

SEPTEMBER 9, 1991

CAN BIG BLUE CHANGE ITS STRIPES?

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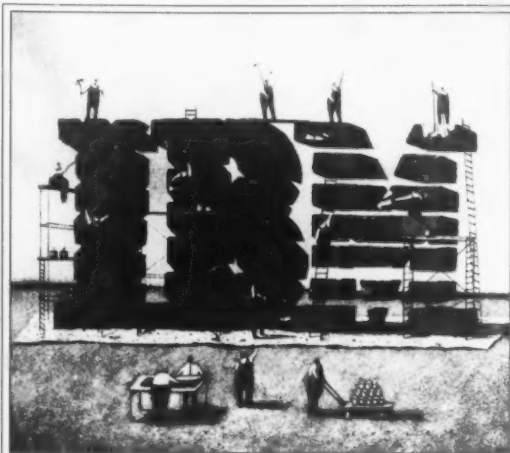
Electronic Business

VOLUME 17, NUMBER 17

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES WORLDWIDE

SEPTEMBER 9, 1991

Cover illustration by David Cutler



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Everyone has his or her own Big Blueprint for getting IBM get back on its feet: Dump its dependence on hardware, cut its bloated work force, team up with customers and even competitors. Surprisingly, it seems chairman John Akers has reached many of the same conclusions. The question is whether the fat old lady of Armonk can move quickly enough or forcefully enough

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EDITORIAL STAFF

Publisher: Frank J. Burge

Editor: John Russell

Managing Editors: H. Garrett DeYoung,
Hugh G. Willett

Senior Editors: Linda Stallmann (Financial),
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Associate Editors: David Webb

Assistant Editors: Barbara Jorgensen

Copy Editor: Elaine M. Cummings

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(Seattle), Madeline Franchi (Cahners
Economics), Sarah Glazer (Boston), Julie
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Economics), Tom McHale, Joel McCormick,
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Consulting Editors: Alberto Socolovsky,
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Senior Production Editor: Karen J. Covey

Assistant Production Editor: Maura A. Baker

Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach

Associate Art Director: Elizabeth Zisa

Staff Artist: Michele G. Kane

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, MA 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: E880S

San Jose, Calif.: Hugh G. Willett,
Teri Sprackland, David Webb
Sherman Building, 3031 Tish Way, Suite 100,
San Jose, CA 95128 (408) 243-8838
Fax: (408) 243-2144

Northwest: Dwight B. Davis
11020 86th Ave. NE
Kirkland, WA 98034 (206) 820-5741

London: Barbara N. Berkman
27 Paul Street
London EC2A4JU England 011-44-71-628-7030
Fax: 011-44-71-628-5984

PRODUCTION

VP Production: Wayne Multizky

Director of Production/Manufacturing:
John R. Sanders

Production Supervisor: Andrew A. Jantz

Production Assistant: Julie T. Kohn;
(617) 964-3030

CIRCULATION

Circulation Manager: Ann Ward
44 Cook Street, Denver, CO 80206
(303) 388-4511

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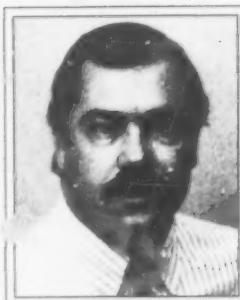
INSIDE BUSINESS

An action plan for IBM

WHAT WOULD you do differently if you ran IBM? That question might have seemed like an utterly idle exercise in the past. After all, IBM has been doing what it does well for so long and on such a massive scale that it would have been tough to find a way any one of us could have added to their winning formula.

That's the past. Today Big Blue is making headlines with a steady stream of bad news: a 92% drop in quarterly income, a work force reduction in the tens of thousands, and a dwindling share of the world computer market. IBM's problems affect customers, suppliers, and investors alike, so it makes sense to scour the industry for the best advice available for a company in trouble.

In researching the IBM cover story, senior editor Rick Whiting and new West Coast managing editor Hugh Willett found agreement among analysts and executives in several key areas. "Rather than ask what was wrong with IBM, we asked what experts would do if they ran IBM," says Hugh, who brings a wealth of Silicon Valley experience as the former technology editor and West Coast bureau chief for *Electronic Buyers' News* to the West



West Coast managing editor Hugh Willett

Coast editorial operation at ELECTRONIC BUSINESS.

IBM, the experts say, needs to focus more on desktop PCs and workstations and de-emphasize the mainframe and minicomputers that it once relied on. In fact, IBM needs to shift its concentration away from computer hardware and focus on software and services.

There is praise for IBM's recent cost-cutting and its strategic alliances with Apple Computer, Lotus Development, and Wang Laboratories as "steps in the right direction," but the experts agree that Big Blue needs to run, not plod.

One important change has been IBM's foray into the OEM channel, reports associate editor Dave Webb. Making components available on the open market will be part of the needed breakaway from dependence on direct sales and support.

"We do know one thing: It will be difficult for IBM to change from a self-sufficient to a nurturing corporate culture," says Hugh. "Joint ventures aren't new to IBM, but until now those relationships have consisted of small companies toeing the party line. The new thinking amounts to a change from dictatorship to democracy."

—By John Parker

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VBPA ARP

BUSINESS TRENDS

FOREIGN INVESTMENT

Who's afraid of the big, bad Japanese buyer?

WHEN IT COMES to buying into the U.S. electronics industry, Japan appears to be getting more for its yen than ever. While some observers see that as a signal for Congressional intervention, others cast the trend in a much more positive light for the U.S. economy.

Japanese equity investments in the U.S. computer, peripherals, semiconductor, and software industries fell from \$2 billion in 1989 to \$980 million last year, according to a recent study by Ulmer Brothers Inc., a New York-based investment banking firm. But the number of Japanese mergers and acquisition-related transactions climbed to 49 last year, compared with 41 in 1989 and just 16 in 1988.

The nature of the investments suggest Japan is trying to cut its dependence on sunset industries such as steel and agricultural machinery, according to Daniel M. Schwartz, managing director of Ulmer Brothers. "Regardless of how leading the acquired technology is, the underlying strategy seems directed at maintaining Japan's strong industrial

base," says Schwartz. The most active Japanese buyers since 1987 have included Kubota Corp., a farm machinery manufacturer, as well as Kobe Steel Ltd. and Sumitomo Metal Industries, both mining and metals concerns.

In past May, Clyde Prestowitz's Economic Strategy Institute unleashed its own study of Japanese acquisitions of U.S. high-tech companies, timed in conjunction with the introduction of a bill in Congress to tighten the U.S. government's review process for foreign acquisitions. Prestowitz believes that Japan's investments in small, cash-strapped companies is weakening the United States' technology lead.

But others take a more sanguine view, in some cases arguing that foreign direct investment has the same potential for boosting efficiency and growth in the 1990s as trade had in the '50s and '60s. DeAnne Julius, chief economist for Shell International Petroleum Co., notes that foreign direct investment is at least one-tenth the size of world trade. But foreign direct investment, says

Julius, is only the initial way in which companies establish themselves in target markets and create flows of goods and services that are "analogous to exports and imports" for years after the initial investment. However, while imports and exports are given much attention during bilateral trade negotiations, global foreign direct investment policy has been largely ignored.

As the protectionists and free traders battle it out, accurate readings of the statistics will be even more critical. The Bureau of Economic Analysis says investment outlays for computer and office equipment companies by all foreigners, including Japan, dropped 65% to \$567 million in 1990 from \$1.6 billion in 1989. Foreign investment in the U.S. components industry fell 3% to \$1.2 billion in 1990 and instruments contracted 5% to \$1.5 billion.

—By Elizabeth B. Baatz and
Linda Stallmann

Japan's \$5 billion stake in U.S. electronics

1987 through first quarter 1991

Industry	Number of deals	Value (\$ millions)
Semiconductors	59	\$2,828.9
Computers	18	1,063.6
Distribution/Sales	10	633.3
Peripherals	31	424.0
Software	23	70.1
Total	141	5,019.9

Source: Ulmer Brothers Inc.

COMMUNICATIONS

User group to address corporate networking needs

ARE CORPORATE users ready to take responsibility for driving the future of computer networking?

A newly formed users group thinks so, and some of the most influential network equipment and software vendors in the industry agree with them.

Still in the start-up stage, Open User Recommended Systems (OURS) was nurtured into existence by local networking software leader Novell Inc. of Provo, Utah. "Large multivendor system environments are coming to the point where the users, not the vendors, need to define what developments need to be done next," says a Novell spokesperson. Novell executives also note the growing complexity of servicing and supporting networks that contain products from many vendors and believe OURS can help formulate methods to ensure adequate multivendor support.

BUSINESS TRENDS

How OURS will achieve these and other goals—such as compatibility testing and rating of network products—remains an open question. The group's steering committee will meet for the first time this fall to hammer out operational and organizational details. "There are numerous possibilities. We still need to figure out what we should do," says committee member Elaine R. Bond, senior vice president of corporate systems at Chase Manhattan Bank in New York.

Other than Novell, which has committed to underwriting the expense of the first steering group meeting, those vendors that support the OURS concept so far have had to contribute little more than their names to the effort. The group's still-undefined agenda and participating vendor requirements have caused at least one major player to hold off in lending its name. Microsoft, of Redmond, Wash., is reportedly waiting to see if OURS will succeed in addressing the needs of large networking users.

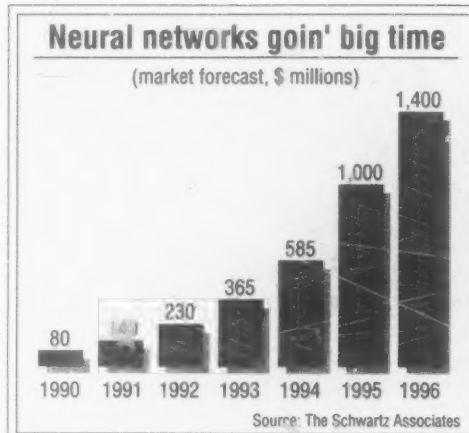
—Dwight Davis in Seattle

ADVANCED COMPUTING

Neural networks are still searching for a market

COMDEX IT WASN'T. When the International Joint Conference on Neural Networks invaded Seattle in July, the city's residents could be forgiven for not noticing. Still, the message of the conference was clear: Neural networks are ready for the big time.

But is the market ready for neural networks? Beyond the rarefied world of research institutions, this specialized branch of parallel computation still generates more head-scratching than brainstorming. Neural networks employ multiple layers of real or simulated processing nodes to first "learn" desired patterns and later to recognize and classify similar patterns. That makes neural networking systems natural candidates for handling such tasks as image



analysis and speech recognition.

A handful of companies offer software tools for developing neural network applications; an even smaller group sells chips, boards, or systems based on neural network architectures. The most successful of these so far are niche vendors such as HNC Inc. of San Diego and Neuralware Inc. of Pittsburgh, which both offer application development tools. HNC also offers the Balboa 860, a hardware coprocessor board for PC/AT and VME-bus computers.

But some better-known companies are also active in the field. At the conference, IBM's Applications Business Systems division exhibited its AS/400 Neural Network Utility for developing and deploying business applications. Intel demonstrated its Electrically Trainable Analog Neural Network chip and discussed a future chip being co-developed with Providence-based Nestor. Corporations presenting reports on in-house neural network projects included Boeing Computer Services and Kodak.

All told, the entire neural network industry generated revenue of about \$80 million last year, according to Tom J. Schwartz, president of consulting firm The Schwartz Associates. Sixty percent came from consulting and development contracts, 25% from hardware sales, 10% from software, and 5% from education and other activities. By 1996 the neural network-

ing market will achieve revenue of \$1.4 billion, and consulting and development will drop to 5% to 10% of the total.

The near-term market will remain that of application developers and researchers, admits John Heightley, president and CEO of Adaptive Solutions of Beaverton, Ore. The company plans to ship its \$55,000 Connected Network of Adaptive Processors system by late this year. Once applications are developed, Heightley ex-

pects the big boom in neural network proliferation to occur as the technology merges with more familiar computer architectures and as it migrates to embedded applications in automobiles and other consumer products.

—Dwight B. Davis

CONSUMER ELECTRONICS

LSI and Sanyo team up to reduce HDTV costs

AS DEVELOPERS fret about the high selling cost of HDTV and suppliers look for ways to jump-start the market, Milpitas, Calif.-based LSI Logic Corp. has teamed up with Sanyo Electric to develop a compact decoder chipset. The chips will be manufactured at Nihon Semiconductor Inc., a joint venture between LSI Logic and Kawasaki Steel.

The smaller chipset will mean lower prices for HDTV sets because of lower component and assembly costs. System costs also will be cut because the printed circuit board area will be about one-fourth the size.

The LSI-Sanyo venture underscores the view expressed during the recent chip talks between Japan and the United States—that U.S. chip companies might find a strong market in consumer electronics as more of these products become digital.

Both companies will have the right to sell the chipset, but the ICs will

BUSINESS TRENDS

work only in HDTV systems designed for Japan's market. While the chipset gets LSI Logic deeper into Japan's consumer-electronics market, it will not be a bonanza. Less than 1 million chipsets will be sold over the next five years, and only 10 million by the year 2000, estimates Itsuro Nishimura of Sanyo's Audio-Video business.

The decoder is a key element in the HDTV system developed by NHK, Japan's government broadcasting company. The picture is broadcast in a complex analog format then digitally decoded in individual receivers. Today, a decoder set is made up of 46 special-purpose ICs plus memory chips. LSI intends to reduce the number to between 6 and 10 chips.

The deal could have other implications. K. K. Yawata, president of LSI Logic in Japan, thinks the chipset will help spur his company's transition from a maker of application-specific ICs to a supplier of application-specific standard products that can be sold to more than one customer.

—Charles Cohen in Tokyo

STRATEGIES

Intel: Under siege or plotting a new attack?

WITH THE PC market in the doldrums and workstation makers migrating toward a half-dozen or more new high-performance microprocessor sources (such as those based on SPARC and Mips RISC architectures), some observers wonder if Intel has had its day in the sun.

Some of the evidence suggests so. Intel CEO Andrew Grove recently told financial analysts that June bookings were disquieting enough to affect sales in the current quarter. Sales of the 80386 family to first-tier customers flattened, and sales to second-tier customers actually dropped. Grove noted that 80486 family sales were on a ramp, but with the system CPU pie split so many ways lately, the best scenario of 486 sales will

probably be only a pale reflection of Intel's success in the '80s with its 386 microprocessors.

There is also a contrary view. Dan Hutcheson, president of San Jose-based analyst firm VLSI Research Inc., claims to see a long-term strategy evolving at Intel that has less to do with microprocessors and more to do with exotic growth markets, such as multimedia. He points to Intel's manipulation of the memory chip market at the end of the 1970s, when it misled Japanese competitors for about four years while preparing to exit the DRAM market.

Hutcheson says Intel is investing the billion dollars a year it intends to spend on R&D not just on the 80x86 family, but also on multimedia and signal-processing capabilities. The forces lining up to "get Intel" may again find themselves holding the bag as the growth in the electronics markets shifts to new products, he says.

With the acquisition of RCA's digital video interactive (DVI) research lab two years ago, the introduction of its i750 DVI processor, and crea-

tion of the multimedia and supercomputing components group last spring, Intel is obviously gearing up to take the lead as multimedia becomes one of the biggest growth opportunities of the '90s.

Meanwhile, the latest financial results still look good: For the second quarter ended June 29, Intel reported revenue of \$1.25 billion, up 29% from \$968 million a year ago. Net income was up 35% to \$231 million, compared with \$171 million. Intel has been profitable for the last four quarters.

—Teri Sprackland in San Jose

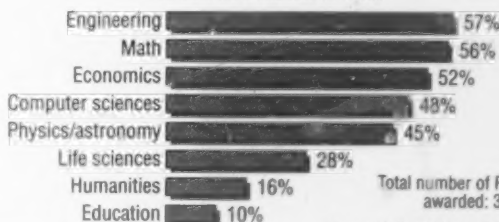
COMPUTER PERIPHERALS

CD-ROM is gaining among top tier computer makers

AT A BREAKOUT session held during a Sun Microsystems Inc. system compatibility conference in July, a Sun product marketing manager outlined Sun's strategy to embrace compact disc/read-only-memory (CD-ROM) peripherals. William Petro, the product manager, said

Foreign students top U.S. engineering education

Percentage of Ph.D.s awarded by U.S. universities to non-U.S. citizens in 1990

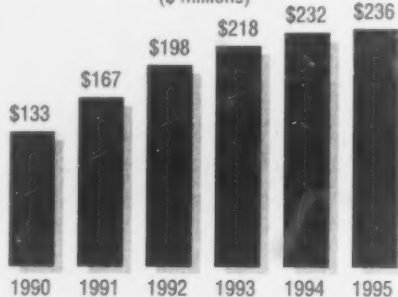


Source: National Research Council

Well over half of the 4,892 engineering Ph.D.s awarded by U.S. universities in 1990 were earned by foreigners; 2,191 of the new engineering doctors had temporary visas and 376 had permanent visas. Foreign nationals accounted for a large percentage of doctorates in math, economics, computer sciences and physics/astronomy as well. Overall, 30% of all doctorates were awarded to non-U.S. citizens last year

—Elizabeth B. Baatz

Systems makers push CD-ROM

CD-ROM drives worldwide revenue
(\$ millions)

Source: Freeman Associates

Sun was not only validating its year-and-a-half-old strategy to incorporate CD-ROM as a software distribution medium, but also validating CD-ROM as a medium.

That isn't too brash a statement, although realistically speaking Sun hasn't single-handedly given CD-ROM the credibility drive manufacturers and CD publishers have long sought. But combined with the CD integration efforts of IBM, Digital Equipment, Hewlett-Packard, and Apple (to name just a few), CD-ROM has finally found celebrity status in the computing world. Three years ago it was tough to find a CD-ROM drive; now they can be found not just integrated into brand-name systems but also on the shelves of electronics superstores and major distributors.

All of the above companies, save Apple, offer CD-ROM options with workstations and file servers, and all seek to eventually shift operating system and application software distribution to compact discs from conventional tape. Apple, of course, is using CD-ROM to not only proliferate its own means of software distribution, but as a critical component of its multimedia market strategy.

Sun appears to be furthest along in the race to add applications available on compact disc and broaden its installed base, but DEC has been working for years to deliver VMS applications to its VAX community.

HP is well along, though it has to balance its software distribution medium of choice between data digital audio tape drives and CD-ROM.

According to Freeman Associates, a storage research firm, worldwide revenue for CD-ROM drives will grow from \$133 million in 1990 to nearly \$167 million this year and \$236 million in 1995. Freeman estimates that 596,000 drives are likely to be shipped worldwide this year. In 1995, says the firm, more

than 1.2 million will be shipped.

Not surprising, there isn't a single U.S. vendor that makes CD-ROM drives. The Japanese—led by Hitachi, Sony, and Toshiba—lead the pack in worldwide market share, followed by Europe's N.V. Philips. On the bright side, U.S. companies hold a strong share of the publishing market, including the market for hardware used to publish compact read-only discs.

—Dave Webb in San Jose

CONSUMER ELECTRONICS

Consumers wait, watch digital recording wars

THOSE UNFORTUNATE consumers with a Sony Betamax video tape recorder packed away in the closet will be paying close attention to the battle between competing formats of digital audio tape and recordable compact discs before making their next audio purchase.

In July, the recording industry reached an agreement with major electronics manufacturers that will clear the way for fully digital recording by consumers. The technology allows home audiophiles to make digital recordings that are virtually indistinguishable from those made and sold by the music industry. Not surprisingly, that has long been opposed by recording companies because it

would cut into their profits on compact discs and other prerecorded music formats.

Under the new pact, a royalty payment based on 2% of the equipment's price (about \$8 per unit) and 3% of the recording media's price (about 25 cents per cassette) would be paid to the record manufacturers on all machines, tapes, and compact discs sold.

What consumers and audio equipment makers haven't figured out yet is which of the several competing digital formats will dominate. At present, three formats are vying for recognition as the digital recording medium of choice:

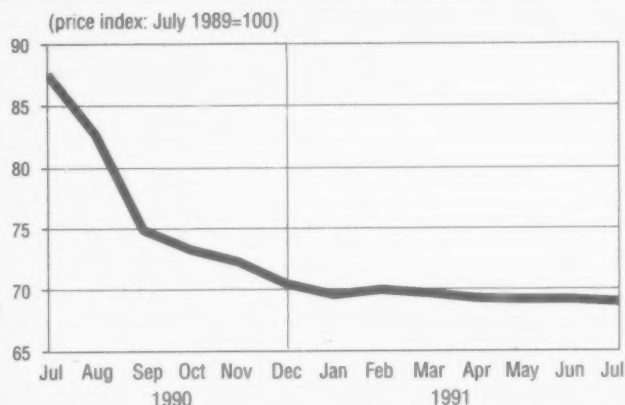
- Standard digital audio cassette players of the type that have been available for several years in Japan. They can play digital tapes but not conventional analog tapes;
- New compact digital cassette players, to be introduced next year by Philips, which are interchangeable with standard audio cassettes and thus allow consumers to use their old tapes. The technology has been endorsed by Japanese audio giant Matsushita Electric and Tandy;
- The Mini Disc, a small compact disc scheduled to be introduced by Sony next year, that can be used to record as well as to play. The Mini Disc players are not compatible with current large-format compact discs.

The upcoming battle of the digital recording formats recalls the days when video recording was a young technology split between the VHS and Sony's Betamax standards. VHS technology was widely licensed and eventually displaced Beta, leaving Beta owners with a dearth of video material for their machines.

The jury is still out on which digital audio recording format will find favor with users, though the match of Japan's audio giant Matsushita with Europe's N.V. Philips seems to give the compact cassettes a slight edge over Sony's Mini Discs for the moment. The market will be watching to see who lines up with Sony this time.

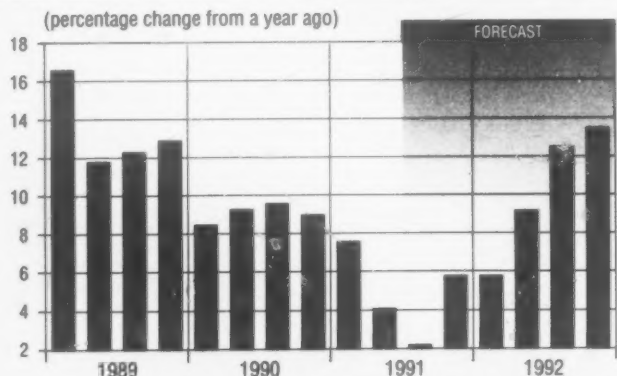
—Hugh G. Willett in San Jose

Semiconductor prices hit the skids



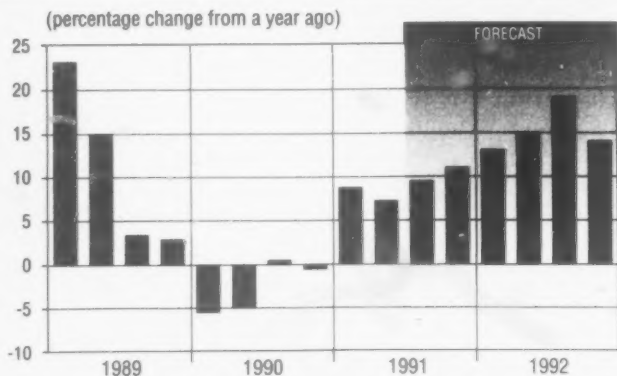
Source: Electronics Purchasing

But rising electronics production...



Source: Federal Reserve Board; forecast: Cahners Economics

...should boost chip sales



Source: Semiconductor Industry Assn.; forecast: Cahners Economics

Chip sales revival continues on a roll

AFTER A disappointing 1990, semiconductor sales so far in 1991 are looking better and better. According to the Semiconductor Industry Association, semiconductor sales to the North American market in the second quarter of 1991 advanced 7.3% from year-ago levels. Although this quarterly gain pales in comparison to the double-digit growth enjoyed in past years, it marks the first two-quarter consecutive increase in sales since 1989.

As for the future, the chip forecast looks even better. With only \$10.8 billion of inventory, the lowest level in three years, computer makers should be replenishing their inventories soon. Computer production at U.S. factories will grow 10.3% next year. Although this is still slow growth by historical standards, each computer will be using more chips than ever, so semiconductor sales should fare better.

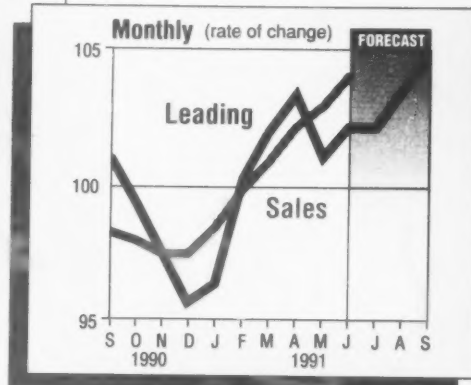
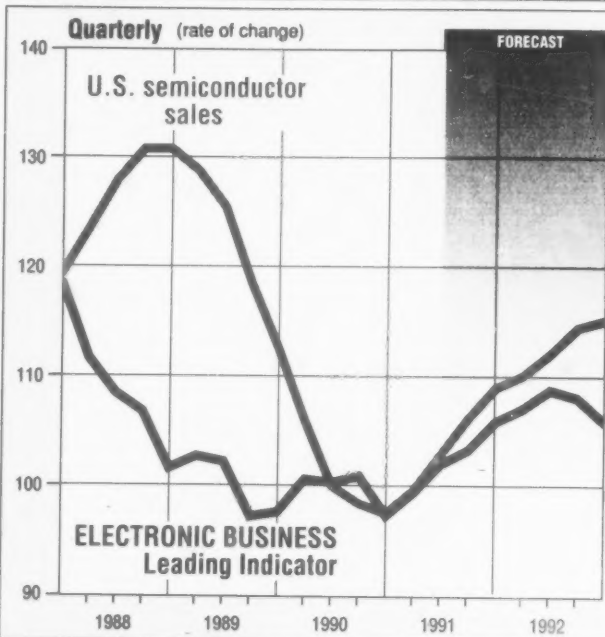
In addition to renewed end-market demand, prices for semiconductor chips also influence the forecast for semiconductors. Based on *Electronics Purchasing* magazine's survey of buyers, semiconductor prices have leveled off recently. The semiconductor price index stood at 69.0 in July, virtually the same as the prior month, and marked the eighth consecutive month that the index registered around the 70 mark. Higher chip prices, however, are expected later this year and next, translating into stronger dollar-valued semiconductor sales.

Cahners Economics expects U.S. chip sales to continue rising throughout the rest of 1991, up 9.1% by the end of the year. Next year will prove to be an even stronger year than previously expected. Look for sales to climb 15.3% to \$18.2 billion in 1992.

—By Julie Handelman

BUSINESS BAROMETER

ELECTRONIC BUSINESS Leading Indicator

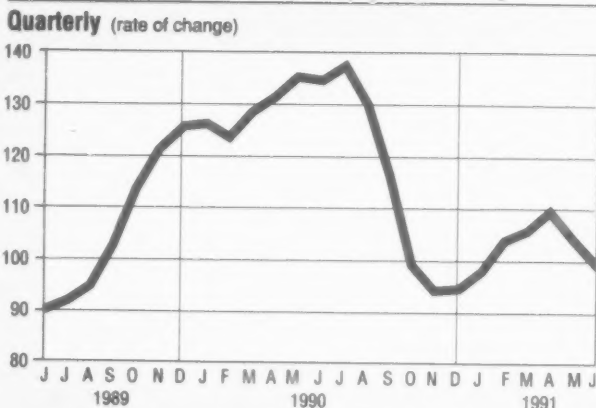


Leading indicator takes a step forward in June

IF THE RECOVERY ends up as one step back for every two steps forward, remember the ELECTRONIC BUSINESS Leading Indicator said so first. The EBLI rose in June to 102.1 after dipping in May; orders for semiconductors declined during the latest two months; and investors, fearing slow earnings growth, are paying less for chip stocks. The EBLI's upward path will be bumpy until a new peak is hit next June.

EBLI is a weighted composite of six statistics that lead activity in the electronics industry. To obtain your complimentary background paper, contact Cahners Economics at (617) 630-2119; fax (617) 630-2100

Semiconductor stock prices in a slump



ELECTRONIC BUSINESS Leading Indicator (rate of change, June)	Latest month	Previous month	Year ago	1990 average
	102.1	101.0	100.1	99.9
U.S. semiconductor bookings (\$ millions, 3-month average, June)	\$1,321	\$1,348	\$1,290	\$1,254
Weekly hours of semiconductor production workers (monthly average, May)	40.9	40.8	40.6	40.4
Electronic components lead time index (1977 = 100, July)	73.7	94.2	82.7	80.7
S&P's semiconductor stock price index (1970 = 10, monthly average, June)	72.2	73.2	79.7	64.6
Change in electronic components inventories (\$ millions, SA, May)	\$31	\$91	\$65	\$33
Contracts and orders for plant and equipment (\$ billions, SA, May)	\$34.0	\$33.0	\$37.7	\$38.3

SA = seasonally adjusted; all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, Bureau of Labor Statistics, Electronics Purchasing, Standard & Poor's, Commerce Dept., Bureau of Economic Analysis

Do or die for Hong Kong chip makers

Low-end competition and lack of capital
may force semiconductor companies into new strategies

By Drew Wilson

Facing stiff competition from Taiwan and Korea in the low-end chip market, Hong Kong's three semiconductor manufacturers—Vitelic (HK) Ltd., RCL Semiconductors Ltd., and Hua Ko Electronics Inc.—seem to be cornered. They can't stay in the low-end market, but neither are they able to compete at the high end.

At least two companies, moreover, can't afford to replace aging equipment, and it is virtually impossible for them to catch up with government-assisted regional competitors that are "\$10 billion and 10 years ahead," according to Charles Chapman, executive director of the Hong Kong Electronics Association (HKEA).

"With ICs you have to keep investing in new equipment and technology if you want high-end work," explains Francis Ko, assistant general manager for RCL. "In the consumer end, capacity is increasing for chips, so we would need between [U.S.] \$800,000 to \$1 million in new equipment to overcome the bottleneck." Without significant government investment, he adds, "there is no chance of competing with Taiwan and Korea."

Vitelic's managing director Raymond Wang agrees, noting that 80% of the production equipment his company acquired last year in its purchase of Hong Kong's Elcap Electronics Ltd. is dated. He argues that the semiconductor industries in the United States, Japan, and Korea were not started by the private sector but through government invest-

ment. "It's a capital-intensive, talent-intensive business, and the Hong Kong government is not aggressively promoting such a thing," he says.

The three small companies that make up Hong Kong's semiconductor industry—housed in modest buildings within shouting distance of each other at Hong Kong's Tai Pao Industrial Estate—are a far cry from the advanced and prolific semiconductor makers of Japan, Korea, and Taiwan. For the most part, they quietly turn out unsophisticated complementary metal-oxide semiconductor (CMOS) chips for low-end products

such as watches, clocks, musical greeting cards, and calculators. Vitelic's Wang estimates that the three companies together do about \$50 million in business "in a good year."

Vitelic's main product in Hong Kong is CMOS consumer-product chips with circuit widths of 2 to 5 microns. It produces 8,000 to 10,000 4-inch wafers monthly, each containing 1,500 to 2,500 chips, on its class-100 production line. It also makes 256-kilobit dynamic random-access memory (DRAM) chips with circuit widths of 0.8 to 1 micron, using a separate class-10 production line.



Without government aid, "there is no chance of competing with Taiwan and Korea" in chips, says RCL's Francis Ko

AS HONG KONG's only DRAM producer, Vitelic makes about 2,000 4-inch DRAM wafers monthly, each containing 200 to 300 chips for products such as PC monitors and "talking" toys. While its DRAM volume is low, Wang says a market for these chips will always exist. The company's chips are packaged at a joint-venture plant across the China border in Shenzhen. Wang says Vitelic's long-term strategy is to use its Hong Kong operation as a verification center for its class-10 line before putting new designs into high-volume production at plants elsewhere.

Although it has no current plans to stop making its consumer chips or 256K DRAMs, Wang says the company wants to put more effort into high-end products such as static random-access memories (SRAMs) and voice and communications circuits. It also plans to develop a 1-megabit DRAM chip by the fourth

quarter, and soon after that a 4-Mbit chip. "We could add a 16-Mbit afterward," says Wang. "It only means we'll have the capability [in Hong Kong]. We'll be doing small runs to verify that the process works."

Vitellic would like to expand production in Hong Kong by year-end to three daily work shifts and a seven-day work week, which would increase wafer production by 30%. The company also hopes to invest \$10 million to switch from 4-inch to 5-inch wafers, which could double the present output. "With the 5-inch wafers, we hope to reach \$40 million to \$50 million per year," Wang says.

BUT ALL THOSE PLANS, and the company's future, depend on obtaining additional financing. The cost of building a still-unfinished second fab in Taiwan, as well as the Elcap acquisition, forced Vitelic to negotiate a merger with Taiwan's Hualon Microelectronics Corp. A letter of intent was signed in April, but at press time the deal still seemed far from certain, partly due to Hualon's difficulties in a securities scandal in Taiwan.

Vitellic's Hong Kong operation does business mainly with local companies. Wang would like to sell low-end chips to China, but he's not counting on it. "China has its own wafer fab industry," he says. "If they get organized, we could all be out of business." Others in the industry disagree, citing China's outdated equipment, inadequate management, and reports that wafer yields at fabs in China are typically 20%—less than one-third of what's considered acceptable elsewhere.

While Vitelic aims to become a test and verification center, RCL Semiconductors is planning for diversification. "We're trying to move out of the low end," says assistant general manager Ko. "You can't survive by chip making in Hong Kong—we want to sell a complete product."

RCL's monthly production of 4-inch and 5-inch wafer lines is reportedly close to Vitelic's monthly 4-inch wafer output. The company con-

tracts its bipolar process work to a mainland factory in Wuxi and also uses subcontractors for packaging.

RCL used to limit itself to low-end chip production for local manufacturers, but Ko says it now needs a more global approach. RCL wants to begin making a complete electronic product—"something between a toy and a personal computer"—that

Hong Kong's chip companies might do well to concentrate on developing innovative niche products

could be sold in the United States, where the company is setting up a marketing office.

Although RCL often uses customer-supplied design, it also has a 20-person design staff. But because it is difficult to recruit and keep experienced designers in Hong Kong, RCL has established a design house in Shenzhen and plans to hire top engineers from mainland universi-

ties. Chinese engineers are highly skilled and they tend to stay with one company, Ko says, adding that RCL will also have a North American design office by 1992.

Hua Ko Electronics, with 250 employees—the smallest of the colony's chip makers—plans to stay on the low-end track, making chips for watches, toys, and clocks, where Mixin Wang, the company's systems manager, insists business is good. The company reported \$10 million in revenue last year.

Bill Kahl, vice president of Asia marketing for National Semiconductor Corp., says opportunities continue at the market's low end. "Transistors, which are the earliest form of semiconductors, are still used today."

Kahl says Hong Kong's chip companies might do well to concentrate on developing innovative niche products. "Semiconductors and applications are so pervasive that the big companies can't be all things to all people," Kahl says. "The big guys focus on areas with maximum return while the small guys fill small areas. With a niche, it's not too difficult to grow to \$50 million to \$100 million."

The HKEA's Chapman adds that the three companies could take advantage of their small sizes to do shorter, more customized chip runs. "The Japanese are too big to do that," he says. "You don't go to Toshiba and ask for 20,000 chips."

Chapman adds that the territory is dependent upon imported semiconductors and that a stronger local chip industry would help to regulate chip price fluctuations. Local producers can stabilize the market, he explains, by stepping production up or down according to demand.

But National's Kahl thinks the lack of an indigenous semiconductor industry isn't necessarily a liability. "Some countries believe they have to stay ahead in semiconductors to compete in electronics," he says. "That's not true. There's a worldwide overcapacity. A lot of companies are competing and that drives the margins down. You don't have to be at the leading edge to compete." □

Hong Kong's three semiconductor makers

Vitellic

Employees:	300
1990 revenue:	\$15 million
Products:	CMOS chips, 256K DRAMS, SRAMs for consumer products

RCL Semiconductors

Employees:	300
1990 revenue:	\$10 million
Products:	CMOS chips for consumer products and LSD displays

Hua Ko Electronics

Employees:	250
1990 revenue:	\$10 million
Products:	CMOS chips for consumer products

Source: Electronic Business Asia

Contract manufacturing grows despite the recession

Or maybe because of it, as electronics and computer makers realize it's cheaper to buy than to make

By Alberto Socolovsky

When Texas Instruments' 99/4 personal computer died in 1984, it caused the shutdown of an assembly line at the company's Johnson City, Ala., plant. Since idle equipment doesn't help the bottom line, TI's plant managers looked for some outside assembly work. But by 1989 TI's contract manufacturing operation had reached only \$50 million in sales, and as recently as last year, it rated only a small paragraph in the company's annual report.

Now called Custom Manufacturing Services and boasting revenue estimated at \$150 million (mostly from surface-mount technology), it has moved higher in the company's organization chart and wider in geography and markets. With five plants in the United States and one in Italy, CMS performs complete manufacturing work for customers ranging from Ford Motor Co. to consumer, communications, industrial, medical, and electronics companies.

The forces fueling TI's growth in contract manufacturing—surface-mount technology and the expansion of TI's customer base beyond computer companies—are also responsible for the growth of this market even in the face of tough times for U.S. electronics and computer companies. A recent study by the Institute for Interconnecting and Packaging Electronic Circuits (IPC) of Lincolnwood, Ill., says the U.S. market for contract manufacturing grew by 20% in 1990 and will keep growing by at least 15% annually through the

1990s. Market researcher Technology Forecasters in Berkeley, Calif., says U.S. customers gave out \$6.5 billion in electronic manufacturing contracts in 1990.

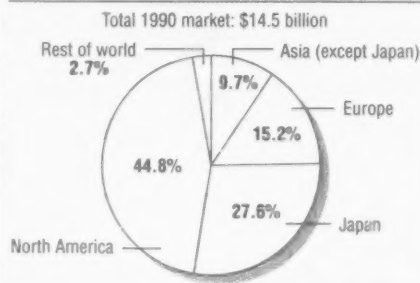
The United States accounts for nearly half of the world market, estimates A. Eugene Sapp Jr., president and CEO at SCI Systems Inc. in Huntsville, Ala., the leading contract manufacturing company with

president Allen L. Shifflett, Comptronix's largest customer in 1988 was Miniscribe, which failed and was acquired by Maxtor Corp. Later Conner Peripherals, Comptronix's largest customer in 1989, succeeded to the point that it needed a higher-volume capacity than Comptronix could provide and switched suppliers. Conner is now a customer of third-largest contract manufacturer Solecron Corp. in San Jose.

But despite the volatile marketplace, disk drives (as well as PCs) remain the largest customers for the top three U.S.-based contractors—SCI, Avex Electronics Inc. in Huntsville, Ala., and Solecron.

IPC analyst Anthony Hilvers shows how much room there is for contract manufacturers to grow. Because the Institute has

Demand for contract manufacturing of electronic equipment



\$1 billion in sales last year. Sapp cautions that, as long as the economy is in recession, "we have to go slow" in adding customers. He speaks from experience. In 1989, SCI wrote off more than \$10 million in unpaid assembly work for Priam Corp., a bankrupt manufacturer of high-performance disk drives.

Fast-growing contract manufacturer Comptronix Corp., based in Guntersville, Ala., shuns disk-drive customers now as well. According to

The top five

Contract manufacturers, ranked by their 1990 sales (\$ millions)

SCI Systems	\$ 1,000
Avex Electronics	265
Solecron	205
Jabil Circuit	180*
Philips W.A. Circuit Assembly	160*

* Estimated

Source: Technology Forecasters

a good handle on total value of printed wiring boards used in the United States—and since PWBs are the most expensive and ubiquitous components in electronic equipment, used by OEMs and contract manufacturers alike—Hilvers estimates that these manufacturers do approximately 12% of the total electronics assembly in the United States. On that basis, the IPC forecasts continued growth for contract manufacturing in the United States through the rest of this decade.

The reason is that contract manufacturers, besides offering up-to-date assembly technology, can do so more economically than their customers can. Last year, OEM productivity measured as sales per employee ranged from \$104,000 for unprofitable Digital Equipment Corp. (which uses hardly any contract manufacturing) to more than \$300,000 for the very profitable Apple Computer and Compaq Computer, both big customers of contract manufacturers.

Another company reaping the rewards of contract manufacturing is Ampex Corp., which sold the assembly plant in Colorado Springs, Colo., of its Audio Video Systems Division to Comptronix. Comptronix gained capacity and a good customer, while Ampex gained cash and the ability to focus more resources on its main business.

THE FAR EAST holds the most potential "for our greatest near-term growth," says SCI's Sapp. Most companies recognize that their offshore competitors benefit from lower labor rates—significant for high-volume products or those with a high labor content.

"We could grow very fast in Asia," confirms Avex's senior marketing manager John Coan. SCI has recently expanded a plant in Bangkok while closing a plant in Southern California. Another large assembler, \$150 million Flextronics International, previously based in California, has restructured as a Singaporean company to operate high-volume

Who buys contract manufacturing

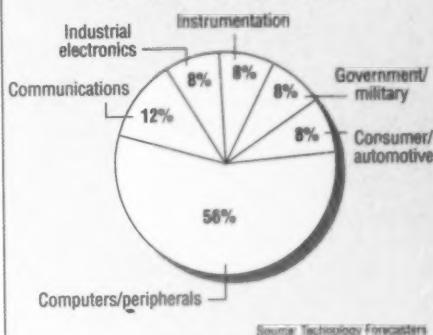
THE INSTITUTE for Interconnecting and Packaging Electronic Circuits (IPC) of Lincolnwood, Ill., conducted a survey last year in which 42 contract assemblers in the United States participated. Their dollar volume, says the IPC, represents 35% to 40% of the U.S. total.

As a whole, computer companies account for half of the business. But these companies favor the larger assemblers. Not surprisingly, consumer/automotive customers accounted for a much smaller market share, because their use of contract assemblers is relatively new.

The major customers of the smaller assemblers are industrial electronics companies, followed by communications equipment concerns. □

How the markets break down

for U.S. contract assemblers (1990)



assembly plants in Singapore, Hong Kong, and the People's Republic of China, leaving stateside only a small prototyping facility in Massachusetts.

Even with the difference in volumes and labor rates, contract manufacturing in Southeast Asia is a merchant environment, "much like in North America and the U.K.," says market analyst Tim Sturgeon of Technology Forecasters. By contrast, he explains, Japan's vertically integrated industry makes contract manufacturers assemble equipment mostly for their parent or affiliated companies. On the other hand, he says, most European (excluding British) contractors are small; the few large ones are U.S. companies. Among the top 10 contract manufacturers ranked by Sturgeon are two British companies, A.B. Electronics and Race Electronics.

Contract houses such as Solecron embraced the concept of total quality manufacturing early on and have successfully dispelled the notion that price is the only reason for using a

contract manufacturer. Lacking products of their own, however, contract manufacturers are at a disadvantage in the competition for the Malcolm Baldrige National Quality Award. Yet Solecron has applied three years in a row, Avex is gearing to apply this year, and practically all of the larger assemblers have quality programs patterned on the Baldrige guidelines—even "six-sigma" programs that aim to drive the number of defects down to practically zero. "Quality is a given [and so are] competitive prices," says Sapp.

Each company claims to have a unique advantage—multinational support at SCI, semiconductor technology at TI—but essentially all offer a close match with the customer's preferences and modus operandi. "Customers ask us to bridge the gap [between their application and] semiconductor technology," says Robert Gilbert, business development manager for TI's CSM. "In contract manufacturing, you are only as good as the last delivery to your customer." □

CONTRACT MANUFACTURING

Type of service

- | | |
|--------------------|------------------------------|
| a Design | d Turnkey manufacturing |
| b Product assembly | e Cable and harness assembly |
| c Testing | |

Over \$50 million

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Dhaval Ajmera, marketing manager; d

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manager; c

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- b Product assembly
- c Testing
- d Turnkey manufacturing
- e Cable and harness assembly

\$5 million to \$20 million

4th Generation

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503-646-4492

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Pioneer Technologies
1-800-227-1693

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404-491-8962

Tech Data
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813-539-7429

Technology Factory
1-800-848-2073
1-800-227-4712

U.S. Computer
305-477-2288

Wyle Laboratories
1-800-289-9953

CONTRACT MANUFACTURING

Type of service

- a Design
- b Product assembly
- c Testing
- d Turnkey manufacturing
- e Cable and harness assembly

MINT Corp.

2650 E. Elvira Blvd., Tucson, AZ 85706;
Tel.: (602) 741-6468; Fax: (602) 741-6419;
Bo Mrozowski, sales director; a,b,c,d

MLI Industries Inc.

3 East Main St., Apalachin, NY 13732;
Tel.: (607) 754-5800 625-216; Fax: (607)
625-2011; Michael MacKenzie, executive
VP; b,c,d,e

National Telephone and Electronics Inc.

2350 NW 96th Ave., Miami, FL 33172;
Tel.: (305) 592-0551; Fax: (305) 599-0948;
J. Ardolino, president; a,b,d,e

Pine Instrument Co.

101 Industrial Dr., Grove City, PA 16127;
Tel.: (412) 458-6391; Fax: (412) 458-4648;
David Savage, marketing manager; a,b,c,d,e

Precision Graphics Inc.

59 LaGrange St., Raritan, NJ 08869;
Tel.: (201) 707-8880; Fax: (201) 707-8884;
Robert Weissman, president; a,b,c,d,e

QPL Electronic Dist. Inc., Cable Tek Div.

22 Terry Ave., Burlington, MA 01803;
Tel.: (617) 229-2424; Fax: (617) 273-5075;
Michael Shaw, president; c,d,e

aRaCoAmo

4100 Burns Road, Palm Beach Gardens, FL
33410; Tel.: (407) 626-7262; Fax: (407)
627-6753; Edward Yonkers, quality
manager; a,b,c,d,e

RAMP Industries Inc.

1 North Floral Ave., Binghamton, NY 13905;
Tel.: (607) 729-5256; Fax: (607) 729-2977;
Charles Faciszewski, sales manager; b,c,d,e

Senior Systems Technology, Inc.

20150 Sunburst St., Chatsworth, CA 91311;
Tel.: (800) 800-0778; Fax: (818) 998-0664;
Joe Candella, president; a,b,c,d,e

Superior Manufacturing Co.

3133 West Harvard St., Santa Ana, CA
92704; Tel.: (714) 540-4605; Fax: (714)
540-4542; Jim Van Landingham, marketing
manager; a,b,c,d,e

SYNTEC Corp.

2201 Donley Dr. Suite 100, Austin, TX
78758; Tel.: (512) 835-4295; Fax: (512)
835-4526; Rodger Schmitt, general
manager; b,c,d,e

Thai Micro Systems

2350 Mission College Blvd., Suite 480,
Santa Clara CA 95054; Tel.: (408) 982-3807,
Fax: (408) 988-3889; Jim Harvey, sales
manager; b,c

Tidewater Associates

3101 Whipple Rd., Suite 27, Union City,
CA 94587; Tel.: (415) 487-5650; Michael
Gifford, director marketing and sales; a,b,c,d

Turtle Mountain Corp.

380 Oak Grove Parkway, St. Paul, MN
55127; Tel.: (612) 481-1427; Fax: (612)
481-7253; Van Barkus, sales manager;
b,c,d,e

Vern Kiebler Electronics Inc.

201 North Gables Blvd., Wheaton, IL 60187;
Tel.: (708) 668-5407; Fax: (708) 462-7590;
Bill Archbold, VP marketing; a,b,c,d,e

Western Reserve Electronics Inc.

2150 Highland Rd., Twinsburg, OH 44087;
Tel.: (216) 425-4951; Fax: (216) 425-4956;
Robert Rhodes, manager marketing and
sales; a,b,c,d,e

Zercom Corp.

Zercom Dr. Box 84, Merifield, MN 56465;
Tel.: (218) 765-3151; Fax: (218) 765-3900;
Jeff Zernov, president; a,b,c,d,e

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Acap Systems, Advanced Products and Technologies

306 River St., Haverhill, MA 01832;
Tel.: (508) 374-8282; Fax: (508) 374-8183;
Val Francisco, VP marketing; b,c,d,e

Accurate Electronics Corp.

169 South Abbe Rd., Box 1287, Elyria, OH
44035; Tel.: (216) 366-6330; Fax: (216)
366-0522; R.B. Seybold, VP; b

Aerospace Industries Inc.

2101 Front St., Cuyahoga Falls, OH 44221;
Tel.: (216) 928-5002; Fax: (216) 928-5283;
David Harry, sales and marketing; b,c,d

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Argo Electronics Inc.

5054 Bleecker Street, Baldwin Park, CA 91706; Tel.: (818) 962-8422; Fax: (818) 960-7312; Gerd Gleim, VP; b,c,d,e

Automation Electronics

9640 Topanga Canyon Place, Bldg. J, Chatsworth, CA 91311; Tel.: (818) 998-5124; Fax: (818) 998-6654; Robert Alani, Q.C. engineer; b, e

Beta Industries Inc.

2860 Culver Ave., Dayton, OH 45429; Tel.: (513) 299-7385; Fax: (513) 299-0468; Tom Biel, electronics manager; a,b,c,d,e

Branmag Inc.

908 Niagara Falls Blvd., North Tonawanda, NY 14120; Tel.: (716) 693-5994; Fax: (716) 856-4802; Branko Veljkovic, president; a,b,c,d,e

'C' Enterprises

310-110 Via Vera Cruz, San Marcos, CA 92069; Tel.: (619) 744-8182; Fax: (619) 744-1659; Steve Rosoff, president; e

Cable Concepts Inc.

30 Perseverance Way Hyannis MA 02601; Tel.: (508) 771-7782; Fax: (508) 778-5771; Judy Cash, sales manager; b,c,d,e

Type of service

- a Design
- b Product assembly
- c Testing
- d Turnkey manufacturing
- e Cable and harness assembly

CAD Engineering and Assembly Inc.

8663 Tyler Blvd., Mentor, OH 44060; Tel.: (216) 255-7744; Fax: (216) 255-5900; Frank Novak, president; a,b,c,d,e

D: P Manufacturing Inc.

32 Hamilton St., PO Box 107, Chalfont, PA 18914; Tel.: (215) 997-1200; Fax: (215) 997-1200; Gunther Diefes, president; a,b,c,d

DARE Electronics Inc.

3245 South County Rd., 25-A, Troy, OH 45373; Tel.: 1 (800) 366-3272; Fax: Paul Gilmore, sales/applications engineer; a,b,c

Data Signal Inc.

2403 Commerce Lane, Albany, GA 31708; Tel.: (912) 883-4703; Fax: (912) 884-4766; William Sanders, president; a,b,c,d,e

Dunham Industries Inc.

17791 Skypark Circle, Suite D, Irvine, CA 92714; Tel.: (714) 261-2308; Fax: (714) 724-1610; Robert Dunham, president; b,c,d,e

E.C.M. Inc.

1515 West 259 St., Harbor City, CA 90710; Tel.: (213) 530-3456; Fax: (213) 530-9161; Wes Kirchoff, president; a,b, e

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Electro-Support Systems

43445 Business Park Drive Suite 108, Temecula, CA 92590; Tel.: (714) 676-2751; Fax: (714) 694-0097; Bob Silcott, president; a,b,c,d,e

Electronic Professional Services Inc.

26351 Curtiss-Wright Pkwy, Cleveland, OH 44143; Tel.: (216) 289-4115; Fax: (216) 289-4116; Jack Bliss, business development manager; a,b,c,d,e

EPS Inc.

26351 Curtiss-Wright Parkway, Richmond Heights, OH 44143; Tel.: (216) 289-4115; Fax: (216) 289-4116; Jack C. Bliss, business development manager; a,b,c,d,e

Eveready Industry Corp.

2085 Zanker Road, San Jose, CA 95131; Tel.: (408) 943-1555; Fax: (408) 943-1248; John Jeng, director engineering; b,c

Griffin Ltd.

1720 - J. Belmont Ave., Baltimore, MD 21207; Tel.: (301) 298-1710; Fax: (301) 265-8404; K.C. Goldstein, president; a,b,c,d,e

Halcyon Microelectronics Inc.

5467 Second St., Irwindale, CA 91706; Tel.: (818) 814-4688; Fax: (818) 960-8133; Dennis P. Martin, president; a,b,c,d

Hutronix Inc.

2400 S. 34th Place Box 27566, Tucson, AZ 85726; Tel.: (602) 790-5348; Fax: (602) 790-8836; Robert Del Ghiaccio, VP marketing/sales; b,d,e

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5224, Fax: (603) 669-1571; Frank Haigh,
director marketing/sales; a,b,c,d

Kurt Manufacturing Co., Electronics Div.

211 St. Anthony Blvd., NE, Minneapolis, MN
55418; Tel.: (612) 572-4415; Fax: (612)
789-7859; Jeff Lenz, manager of electronics
division; a,b,c,d,e

Libra Industries Inc., Electronics Division

7555 Tyler Boulevard, Mentor, OH 44060;
Tel.: (216) 951-9777; Fax: (216) 951-8145;
Mitchell Bednarek, marketing manager;
a,b,c,d,e

MANU-TEC Inc.

415 West Belden Ave., Addison, IL 60101-
4933; Tel.: (708) 543-3022; Fax: (708) 543-
7766; Richard Zboril, president; a,b,c,d,e

Micropolish

Z.I. des Pradeaux, 13850 Greasque, France;
Tel.: (33) 42-699104; Fax: (33) 42-699470;
Gerard Gilles, president/CEO; b,

Type of service

- a Design
- b Product assembly
- c Testing
- d Turnkey manufacturing
- e Cable and harness assembly

Mitech Electronics Corp.

411 Washington St., Otsego, MI 49078;
Tel.: (616) 694-9471; Fax: (616) 692-2651;
Kendall Meyer, director sales and marketing;
a,b,c,d,e

PC Express Inc.

15103 US Highway 19, Hudson, FL 34667;
Tel.: (813) 863-6114; Fax: (813) 862-4547;
Charles Lent, president; a,b,c,d

Qual-Pro Corp.

18101 Savarona Way, Carson CA 90746;
Tel.: (213) 329-7535; Fax: (213) 399-0201;
Gerald Shane, president; a,b,c,d,e

Quay Corp.

22 Meridian Rd., Eatontown, NJ 07724;
Tel.: (908) 542-7340 Fax: (908) 389-1931;
Helena Gergitis, director sales; a,b,c,d,e

R and M Electronics

Box 1107, RD #5, Gibsonia, PA 15044;
Tel.: (412) 443-8222; Fax: (412) 444-6833;
Michael Hutchinson, president; a,b,c,d,e

Radio Television Products Corp.

2702 Washington Ave. North, Douglas AZ
E85607; Tel.: (602) 364-4438; Fax: (602)
364-4430; W.J. McGaw, president; b,c,d

Rel-Tech Electronics Inc.

955 Connecticut Ave., Bridgeport, CT 06607;
Tel.: (203) 333-8190; Fax: (203) 332-0417;
W.D. LeBlanc, Jr., VP; e

SeaFab Inc.

14648 N.E. 95th St., Redmond, WA 98052;
Tel.: (206) 881-2778; Fax: (206) 882-0707;
Bruce Murray, president; b,c,d

Sensor Scientific Inc.

6 Kings Bridge Rd., Fairfield, NJ 07004;
Tel.: (201) 227-7790; Fax: (201) 227-8063;
Robert Brimley, president; b,d,e

Silicon Valley Turnkey

2346 Bering Drive San Jose CA 95731;
Tel.: (408) 944-9500; Fax: (408) 944-9422;
Marlene Rozett, president; a,b,c,d,e

Southtronics Incorporated

1265 Kennestone Circle, Marietta, GA
30066; Tel.: (404) 429-1000; Fax: (404)
424-2000; Randy Staton, marketing
director; a,b,c,d

Test Group Inc.

10225 Barnes Canyon Rd., A-109, San
Diego, CA 92121; Tel.: (619) 452-4160;
Fax: (619) 450-9639; Duane Sorlie, vice
president marketing manager; b,c

Time Mark Corp.

11440 East Pine St. Tulsa, OK 74116;
Tel.: (918) 438-1220; Fax: (918) 437-7584;
Steve Purle, national sales manager;
a,b,c,e

Trionics Inc.

704 East North St., Elburn, IL 60119;
Tel.: (708) 365-6570; Fax: (708) 365-6575;
James Teppo, president; a,b,c,d,e

VerTek International Inc.

9465 Custom House Plaza, Suite D, San
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